

CONTEMPORARY METALLIC MATERIALS

Md Abdul Maleque
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Edited by:

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Mechanochemical Synthesis of CeO₂ Nanopowder using Planetary Ball Milling

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Abstract. Nanocrystalline cerium dioxide (CeO₂) had been successfully synthesized by mechanochemical technique at 12, 24, 36, 48 and 60 hours milling times. The starting materials, hydrated cerium carbonate and sodium hydroxide, were mixed in weight ratio of 4:1 and were milled in a planetary ball mill with ball to powder ratio of 10:1. The high energy impact forces provided by the milling media caused collision of starting materials and allowed the chemical reaction to occur thus produced nanocrystalline cerium dioxide. The products were then characterized using a battery of characterization methods, including thermogravimetric analysis (TGA), differential scanning calorimetry (DSC), X-ray diffraction (XRD), and gas adsorption-desorption measurement. The nanocrystalline CeO₂ with 6.7 nm of crystallite size and specific surface area of 66.66 m²/g was obtained when the sample was milled for 60 hrs and annealed in air at 350 °C. The result showed that the crystallinity of nanocrystalline CeO₂ decreased with increasing the milling time.

Introduction

Synthesis and processing of nanometer size of CeO₂ have drawn considerable attention in recent years due to its physical and chemical properties that are significantly different from those of bulk materials. As one of the most important rare earth oxides, CeO₂ has been widely applied in various fields including polishing materials, environmental catalysts, UV-attenuating coating, fuel cells, and so on [1,2]. Several processing method have been proposed to produce nano-sized CeO₂, such as solgel process, homogeneous precipitation, microemulsion, hydrothermal synthesis, forced hydrolysis, and spray pyrolysis [3].

Recent studies have shown that mechanochemical processing holds significant potential for the synthesis of a wide range of nano-sized metallic and ceramic powders in an efficient and economical manner [4,5] The process involves mechanical milling a mixture of precursor powders to form nanostructured materials. The starting powders react either during milling or subsequent heat treatment so that separated nanocrystals of desired phase embedded in a salt or oxide matrix can be obtained [6] Usually, the mechanochemical process is performed by